BEYOND TEXTBOOKS

Support for Differentiation: Implementing eSpark

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Support for Differentiation: Implementing eSpark

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INTRODUCTION

Multipurpose portable devices, such as the Apple iPad and iPhone, and the new digital content they support are becoming increasingly popular in classrooms across the nation. As a result, the Virginia Department of Education has embarked upon a series of pilot studies to investigate the use of digital content and curricular materials on these devices. The *Beyond Textbooks* pilot is a project of the *Learning Without Boundaries* initiative—overseen by the Department's Office of Educational Technology—which seeks innovative ways to provide ubiquitous access to educational resources that support teaching and learning.

Educators at all levels try to differentiate instruction to meet the diverse needs of all their students. To support educators in this effort, the Department initiated a short-term pilot of the eSpark application (app) and service provided by eSpark. In 2012, classrooms in six divisions across Virginia were given access to Apple iPads and services and software from eSpark to investigate how teachers and students would react to a product designed to help differentiate instruction. This digital application aligns the presentation of instruction and content to student learning goals, as determined by past performances on assessments and feedback from teachers.

The pilot and this evaluation explored the experiences of teachers and students with this app as it promotes reading and mathematics instruction. A comparison group of six classrooms was also given access to iPads but not the eSpark app or service; although, the comparison group did have access to other apps. Data from these teachers and students were incorporated into the evaluation. In addition, an adaptive computer-based assessment was administered before and after the pilot to determine student growth in targeted areas (reading and mathematics).

Differentiated instruction is generally recognized as the adjustment of content, processes, or products to meet the various needs of diverse student learning preferences, abilities, and interests. The eSpark service and app is intended to jump-start that process for teachers by using existing student performance data and input from teachers to align learning activities with individual learning goals.

The evaluation uses a mixed-methods approach that incorporates perception data from teachers, students, and technology support personnel from the six divisions as well as a comparison of student performance on an adaptive computer-based assessment administered before and after the pilot. While many educators use the term *differentiated instruction*, it was important to describe characteristics of differentiated instruction for the evaluation to clearly identify if and how the eSpark app and process helps teachers differentiate instruction for their students. As such, the evaluation sought to address the following central question:

How does eSpark (the app and process) support the differentiation of instruction?

In relation to this one central question, the following subquestions were used to determine more fully if and how the eSpark app and process can and should be used to support differentiated instruction:

- What is the nature of support, including professional development, required for teachers to be able to differentiate instruction for students using the eSpark app and process?

- How does student academic achievement compare among students who use iPads with the eSpark personalized learning app and students who use iPads without the app?

This report presents findings from the 10-week pilot project, incorporating feedback from teachers, students, and educational technology staff in the selected schools, including both pilot and comparison classrooms. It focuses primarily on how the teachers and students used the *eSpark* app and related services as well as a comparison of student learning as measured by the pre- and post-test of knowledge.

OVERVIEW OF THE PROGRAM

What is differentiated instruction?

The National Center on Accessing the General Curriculum defines differentiated instruction as "a process to approach teaching and learning for students of differing abilities in the same class" (Hall as cited in Huebner, 2010). It refers to teacher actions that go beyond simply assigning some students more or less work (Protheroe, 2007). Tomlinson and colleagues (2003) define differentiation as "an approach to teaching in which teachers proactively modify curricula, teaching methods, resources, learning activities, and student products to address the diverse needs of individual students and small groups of students to maximize the learning opportunity for each student in a classroom" (p. 121). As opposed to more traditional types of classroom instruction, differentiation focuses on modifying content and instruction to individual students rather than expecting the students to adapt to the curriculum.

According to Levy (2008) and others (Rock, Gregg, Ellis, & Gable, 2008; Tomlinson & Imbeau, 2010), students do not come to school with the same background experiences, knowledge, and abilities; these differences greatly impact the content teachers can provide and the instructional strategies they can use. To differentiate instruction, teachers try to ascertain the prior knowledge of their students and adjust their teaching strategies to meet specific student needs.

Logan (2011) suggests that differentiated instruction refers to classroom practices related to accommodating student learning styles, interests, and prior knowledge. While different models and frameworks help teachers implement differentiated instruction (Gould & Vaughn, 2000; Rock et al., 2008; Tomlinson & Imbeau, 2010; Wormeli, 2003), there is little empirical research to support the effectiveness of differentiated instruction, perhaps because it is not a set process or procedure; however, research does support a range of practices and processes that can be incorporated into differentiated instruction (Huebner, 2010), including the following:

- effective classroom management procedures
- promoting student engagement and motivation
- assessing student readiness
- responding to learning styles
- grouping students for instruction
- teaching to the students' zone of proximal development (p. 79)

Teachers want to meet the specific needs of their individual students, so many adapt their lessons on the fly during instruction (Gould & Vaughn, 2000; Tomlinson et al., 2003); however, with differentiated instruction, teachers plan for explicit and specific behaviors to accommodate their students' learning needs. This does not mean that they follow the same steps or processes, like following a menu; rather, they develop unique accommodations customized to the needs of their students. Teachers can differentiate content, processes, or products based on their students' readiness levels, skills and knowledge required by the content, interests, and learning preferences (Anderson, 2007). Content, processes, and products may vary within a classroom, but all students still work toward mastering the same standards and learning objectives.

How do teachers do this? Teachers who differentiate instruction provide their students with choices, are flexible, and use ongoing assessments to monitor student progress and determine individual needs. They may begin by assessing and/or creating student learning profiles that identify their preferences, interests, and backgrounds (Anderson, 2007; Tomlinson et al., 2003). They may develop formal learning profiles by using inventories for different learning preferences and intelligences (e.g., Gardner's theory of multiple intelligences) or less formal profiles by considering a student's gender or culture. According to Pettig (2000), choice validates students' opinions and can promote self-efficacy. She encourages choice be offered in at least one of the three key aspects of instruction previously mentioned: content, process, or product.

Differentiated instruction can be a challenge. It requires teachers to understand the academic needs and abilities of students as well as their interests, preferences, and preferred styles of learning. It can also be a challenge to manage an entire classroom of students who are exploring different content, using different learning strategies, and creating unique products. Differentiated instruction takes time and effort and goes beyond understanding a few grouping strategies; teachers must plan proactively and constantly monitor student performance. The eSpark service and app is intended to provide support for teachers who wish to differentiate instruction by matching instruction to indicators of student understanding and learning outcomes and by providing a means for monitoring student performance on a continual basis.

Participants

The Virginia Department of Education sought school sites from divisions across the state. Originally, 14 classrooms (seven treatment and seven comparison) from six divisions agreed to participate in the pilot. The classrooms initially ranged from second to seventh grade. Ultimately, one division, Harrisonburg, with two grade levels—fifth and seventh—could not fulfill the required time commitment of providing at least 90 minutes of class time per week to the devices and apps. Data from these four classes were not used in the achievement data analysis, but these teachers, students, and technology personnel were interviewed for the report. The participating students in Harrisonburg were enrolled in remedial classes. All the remaining classrooms in the pilot were second grade.

Each treatment classroom was compared with a classroom in its own division. Comparison classrooms also had access to student iPads and a range of apps but did not have access to the eSpark app or process.

Table 1 lists the divisions that participated in the pilot. As noted, Harrisonburg did not complete the pilot. The Total columns represent the full number of students who participated in the pilot at some time, while the Completed columns represent those students who completed both the pre- and post-test and who participated for the full pilot. Attrition can be attributed to typical transfers between classrooms or schools and students being absent on one or both of the test dates.

Division	Grade	Subject	Total Pilot	Completed Pilot (Tested)	Total Comparison	Completed Comparison (Tested)
Franklin	2nd	Math	20	20	16	15
Hampton	2nd	Reading	22	20	21	20
* Harrisonburg (1)	5th	Remdial Math	8	0	5	0
* Harrisonburg (2)	7th	Remedial Reading	15	0	11	0
Portsmouth	2nd	Reading	24	20	21	20
Roanoke	2nd	Math	22	21	24	24

* Did not complete the pilot

Table 1. *Participant numbers and divisions*

Pilot program description and content

eSpark is intended specifically for teachers with access to iPads who wish to differentiate instruction. The service includes a student app for the iPad that coordinates access to third-party curricular apps and other digital content through an educational quest comprised of a series of eight challenges, each designed to take between 10 to 20 minutes. The eSpark mission is to make learning fun for K-8 students and help them succeed in school and life.

Once the apps were installed on the iPads, schools generally followed one or more of three different instructional models. In the first model, Core General Education, teachers could use eSpark to address the general student population with activities aligned to curricular or student needs. This model could be used in what many Response-to-Intervention (RtI) models refer to as Tier 1, which usually means that the instruction is appropriate to approximately 80% of students. In the second model, Special Education RtI, eSpark was most often utilized by special education or other intervention teachers to address the needs of students with individualized education plans (IEP); this population of students is similar to Tiers 2 and 3 in many RtI models. The third model was an extended-day model in which students could use eSpark in a facilitated setting after primary instruction. In this model, eSpark activities are aligned to student needs or choices and can be facilitated by a designated teacher, after-school provider, or other facilitator. This model does not target specific populations of students since the activities are aligned to individual student learning goals. In all of the instructional models, eSpark could be incorporated into varied group settings, with students working independently or in groups.

eSpark uses three types of student assessment data to determine student learning goals and assign relevant instructional resources:

1. Data from an online mathematics and/or reading diagnostic assessment
2. Student scores from standardized tests (schools provide whatever data they have available, whether benchmark or summative)
3. Data from a checklist based on 12 common core domains, which teachers can use to evaluate student performances manually

Using student assessment data generated by one or more of these methods, eSpark developed a learning profile for each student. After the teacher confirmed the learning profile, eSpark recommended goals for each student. The eSpark process recommends goals based on the new Common Core standards; however, Virginia opted out of the Common Core in lieu of using its state-based Standards of Learning (SOL). Teachers in the pilot did not report any difficulty in aligning the eSpark recommendations with SOL.

Once learning goals for all students were determined, apps were identified for individual students. eSpark identified both free and for-fee apps; schools using the service had to purchase and install the recommended apps from the iTunes Store. As part of its service, eSpark helped school and division personnel install and manage the many different apps.

Figure 1. *An eSpark quest comprising eight challenges*

Figure 2. *Mood icons and private chat allowed students to communicate with their teachers.*

Students interacted with the eSpark app through a series of *challenges,* which could be an app or a specific part of an app (such as a single game or section within an app), an instructional video, an e-book, a podcast, or an educational Web site. Eight challenges are focused around a central learning goal and presented as a single *quest* (see Figure 1). Each challenge is designed to last between 10 to 20 minutes. Students in the pilot were encouraged to complete up to 64 challenges (or 8 quests) over a 10-week period. During this time, teachers could review student progress through a teacher interface called the eSpark Mission Control. Students could receive a new quest after mastering their currently assigned one.

Of the eight challenges presented in an eSpark quest, the first is intended as a "hook" to pique students' interest. It could be an app, an e-book, a game, or other content that orients students toward their learning goals. For the second challenge, the eSpark app links to a third-party instructional video to provide students with foundational instruction related to the content. Challenges three through seven allow students to practice and apply skills from the instruction by accessing all or part of an app. Students receive instructions for using the apps; these could focus on targeted skills or allow students to skip challenges that are too difficult. For challenge eight, students create a video using the iPad's built-in camera to demonstrate what they have learned. This product helps demonstrate student mastery of the learning goals. Currently, students notify their teachers when they complete their

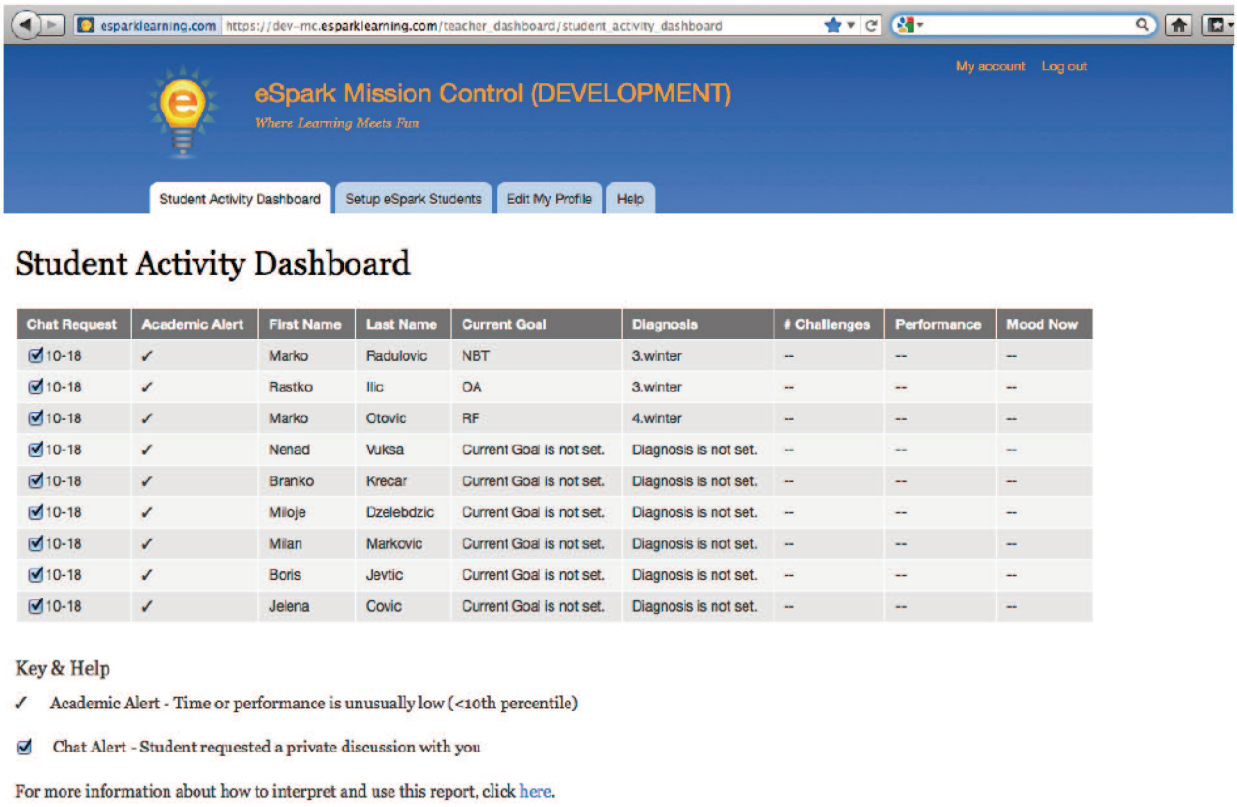

Figure 3. *eSpark Mission Control helps teachers keep track of student progress.*

individualized learning plans.

Students can provide feedback about the apps that have been selected for them. On March 7, just after most of the pilot schools held their kickoff meetings, eSpark launched a new feature that allowed students to communicate with their teachers using a "mood and private chat check-in" (see Figure 2). This allowed them to enter text about their progress and take a quick poll to report how well they liked the app. They could also request private chats with their teachers or select icons to express how they felt (such as happy, proud, excited, bored, or frustrated) in relation to their progress. Not all of the schools in the pilot opted to include this feature.

eSpark identifies and reviews all the apps to be included in the process. To review the apps, the company works with teachers who have earned at least a master's degree in education and who have significant classroom experience, including the use of an iPad in their classrooms for at least a year. Apps are initially selected based on whether they are (1) academically rigorous, (2) aligned to the Common Core standards, and (3) fun. According to staff at eSpark, there has been an ongoing conversation by its staff and the reviewers about what makes an app "fun." Currently, an app is considered fun if it meets the following criteria:

- Game like
- Frequent small rewards tied to larger achievements
- Challenging
- Clear goals and objectives

- Driven by a character or narrative
- Surprise or whimsical elements

The teacher eSpark interface, called eSpark Mission Control, provides teachers with data on their students' progress. They can easily see if student performance is unusually low by the presence of a checkmark in a column labeled "Academic Alert" (see Figure 3). This interface also lets teachers know if students have requested private chats. All schools had access to continued support from eSpark via phone or e-mail throughout the pilot; however, since Virginia schools have access to instructional technology resource teachers (ITRT), some of the classrooms did not rely heavily on support from eSpark. Participating teachers in the pilot classrooms in Hampton, Roanoke, and Franklin counties scheduled weekly calls with staff at eSpark for the first four weeks of the pilot and then called as needed. Staff in the Harrisonburg schools communicated with eSpark personnel through e-mail. Schools in Portsmouth communicated with eSpark through their ITRT.

Pilot program goals and activities

Classrooms selected for the project had to have 1:1 access to iPads for all students. The iPads were not provided by the project. In some schools, access was provided through a classroom set of devices, which sometimes were shared with both treatment and comparison classes. The Virginia Department of Education obtained the following commitments from all participating divisions:

- Provide support to allow one teacher and at least one technology support person to attend professional development and to be involved in the project for the length of the pilot (10 weeks).
- Provide data for participating students in both the pilot and the comparison classrooms.
- Ensure that the students have 90 minutes or more of class time per week to use the iPads (if students could take the iPads home, some of this time could be outside the classroom).
- Purchase, download, and install recommended third-party learning apps.
- Provide technical support for teachers regarding the iPad devices.

The Department obtained the following commitments from eSpark:

- Provide initial training for all participants to initiate the pilot process; provide specific training on the eSpark app and eSpark Mission Control interface for teachers; and work with students to set goals based on data and teacher objectives.
- Install and configure the eSpark app on all student iPads and provide teachers with access to the eSpark Mission Control.
- Use data from schools to match students with apps based on need.
- Work with teachers and students to help choose the particular goals to be addressed during the pilot and configure the individualized challenges for the students.
- Provide continual training and 24/7 support for all pilot teachers and support personnel.

The Department committed to the following:

- Organize pilot logistics and maintain contact with all pilot participants during the pilot and provide mediation for any problems that arise.
- Determine a research plan with assistance from eSpark personnel and division personnel.
- Implement a research plan.
- Disseminate the results of the research.

Participating teachers attended a one-day introduction provided by eSpark. This included an overview of the eSpark process, app, and the eSpark Mission Control teacher interface. Also, during this day, the classroom sets of iPads were configured to support the eSpark service.

Each site also received one site visit by eSpark personnel during the pilot. During this visit, a staff specialist from eSpark could coteach lessons with the pilot teachers or converse with key personnel. Franklin and Roanoke counties received their site visits in conjunction with the student kickoff. Hampton, Harrisonburg, and Portsmouth received visits midway through the pilot and, as such, began the pilot without eSpark personnel on site.

All of the pilot classrooms launched the eSpark initiative through a student kickoff in January 2012. Pilot classrooms used the eSpark and related apps for approximately 10 weeks. Some comparison classrooms had access to the same apps, except for the eSpark app, as their treatment counterparts. Students in the pilot and comparison classrooms then completed pre- and post-tests of knowledge using the Diagnostic Online Reading Assessment (DORA) or the Diagnostic Online Math Assessment (DOMA) from Let's Go Learn, Inc. (See data collection below for more information about these tests.)

EVALUATION DESIGN

Data collection and methods

Teachers in the treatment group participated in individual interviews and answered questions based on their uses of the eSpark app, any changes in practice, levels of support they received, and their perceptions of how well the product matched the intended goals (see appendix). Teachers in the comparison classrooms also allowed students to use apps—other than the eSpark—on their iPads during the normal instruction, sometimes using the same apps used in the treatment classrooms; this was possible since the apps were usually available on the same devices. Their answers during individual interviews focused on the use of the iPads and any apps related to the subject of study (mathematics or reading). An interview protocol was used to structure interviews for all groups.

Instructional technology support personnel—often consisting of the school or division ITRT but by other support personnel, as well—also participated in interviews and reported their perceptions related to implementing and maintaining the eSpark app and iPads, levels and types of technology support they provided, and any observations of use.

Small groups of students from both the treatment and comparison classrooms were also interviewed to obtain their observations, especially with regard to the eSpark app in the treatment classrooms.

As is common with analyzing qualitative data, interview data were reviewed for themes for the purposes of grouping and coding (Creswell, 2009). Codes were not predetermined; however, they were sought in relation to the questions guiding the evaluation. Additional codes may relate to information that was not expected or that became known during the evaluation process. This process is often cyclical and not only requires repeated data review but may include follow-up questions for participants or others involved in the study. All findings and interpretations were shared with staff at the Virginia Department of Education, relevant staff at eSpark, and the participants to provide the most accurate representation of actual events and uses.

All the participating students also completed the Diagnostic Online Math Assessment (DOMA) or the Diagnostic Online Reading Assessment (DORA) from Let's Go Learn, Inc. (http://www.letsgolearn.com/) both prior to and following the pilot period. Students took either the mathematics or the reading test based on the subject of their learning goals. All students in the same class focused on the same subject (mathematics or reading) but may have had different goals in those subject areas (for example, students in a class focusing on mathematics may have had goals related to learning number strands, fractions, or measurement). The tests were administered online and were adaptive, meaning that students might have seen a different number of items based on their responses.

According to the publishers (Let's Go Learn, n.d. a), the DOMA: Basic Math Skills assessment consisted of three subtests with a varied number of criterion-referenced items in multiple constructs from kindergarten through fifth grade:

- Numbers and operations: 204 items in 56 constructs
- Measurement: 104 items in 28 constructs
- Fractions: 58 items in 18 constructs

The DOMA is aligned to state standards in all 50 states but has no published measure of construct validity. Using a Rasch model with a sample of 4,675 K-12 students from nine schools across the nation, the publishers report a high level of reliability for each subtest.

Similar to its mathematics counterpart, the DORA is an adaptive test that uses a set of subtests with criterion-referenced items in multiple constructs from kindergarten through fifth grade (Let's Go Learn, n.d. b). Students in the pilot program took the following seven (of eight) subtests:

1. High frequency words: 72 words drawn from Edward B. Fry's 300 sight words with 24 words per grade from first to third grade; accurate identification and response times were factored into student scores
2. Phonemic awareness: audio and picture-only items that students manipulate to demonstrate their understanding of the 40 English language phonemes
3. Phonics: 80 criterion-referenced words with 20 words per grade from first to fourth grade

4. Word recognition: 120 leveled words with 10 words per grade from first to twelfth grade
5. Vocabulary: pictures that correspond with spoken words, drawn from 60 criterion-referenced words with five words per grade from first to twelfth grade
6. Spelling: 60 criterion-referenced words with 5 words per grade from first to twelfth grade
7. Silent reading comprehension: three factual questions, two inferential questions, and one contextual vocabulary question, answered after reading passages of increasing difficulty using one Flesh-Kincaid leveled passage per grade

In the past, DORA had been compared to multiple paper-and-pencil assessments, which led to revisions and increased measures of construct validity. A Rasch model was used with samples of K-12 students ranging from 1,596 to 10,534 in six districts from California, Colorado, Hawaii, and Virginia. Reliability levels were high for all subtests except phonemic awareness, which is administered only to younger students and which consists of few items.

An analysis of student performance on the pretest indicated no significant differences between the percentage of students on or above grade level in the treatment versus control classrooms.

Limitations

This mixed-method evaluation relied on a variety of data to obtain a fuller picture of how the eSpark app and process was implemented and to address the evaluation questions. However, all data must be viewed in the light of known and expected limitations. Much of the qualitative data is from interviews, and, while an interview protocol provided an equalizing structure for the interviews across the sites, interactions with the interviewer and others—for focus groups as opposed to individual interviews—could have biased or informed responses. Those being interviewed also could have misunderstood or misinterpreted terms used during the interview, especially when those terms had not been defined and agreed upon ahead of time. In cases where contradictions occurred—either with previous responses or with responses from others in the same school—efforts were made to seek clarification.

An extra concern is that most of the students interviewed were in the second grade. These students not only have limited vocabulary and understandings but may lack adequate social skills to interact with adults. To help support these students, interviews were conducted in groups, often with a familiar adult, such as the children's teacher, present.

Because two classrooms could not meet the basic requirement of providing access to the eSpark app and related instruction 90 minutes a week, the quantitative data are limited in that they include only second-grade students. The original intent was to incorporate older students as well; this would have helped counter the limitations of the second-grade students' basic literacy skills, which could have negatively impacted their performances on the mathematics applications and assessments. The age and limited technology skills of some students could also be considered a limitation. While most reported that they could operate the iPads easily, some—following later questioning—reported difficulties, especially when creating videos.

Scores on the DOMA and DORA also were limited in terms of the types of analyses that could be conducted. These scores are reported as whole numbers, representing a corresponding grade level followed by a decimal score. The decimal scores do not represent an interval scale, such as a month or approximate grade level (a score of 2.17 does not mean the student reads at a grade level equal to 1.7 months into the second grade). These scores are best described as a nominal or categorical measure. On these tests and subtests, it is not possible for students to achieve all scores between .00 and .99 within a grade level; instead, the scores represent how students performed based on categories, such as below, at, or above grade level. The use of nominal data limited the types of comparisons that could be made with the assessment data.

Data analysis

Differentiation Background Knowledge

During interviews, all but two of the 12 treatment and comparison teachers reported having "a lot" of prior training or professional development related to differentiated instruction, and all reported that they understood the concepts of differentiated instruction very well. Only one teacher—in the comparison group—did not report having "a lot" of prior professional development related to differentiated instruction. One teacher in the treatment group also equated the term "differentiation" with "diversification" as it relates to the use of diverse technology, so that teacher may have misinterpreted the question.

Treatment and comparison teachers reported similar levels of support *within their divisions* for differentiating instruction. For example, one teacher in a treatment classroom reported receiving a good deal of support from her division through the access to technical support, professional development, and flexible scheduling. This high level of support was echoed by a teacher in a comparison classroom from that same division. All teachers reported moderate-to-high levels of support from the system in which they worked. The reports within each division were largely consistent, even in those divisions reporting less support. No teachers reported receiving no or low levels of support for differentiation.

Differentiated Instruction Practice

Teachers were asked if they grouped students and, if so, how? Grouping is often an indicator of differentiated practice, but the grouping should be purposeful and planned (Levy, 2008; Pettig, 2000; Tomlinson et al., 2003; Tomlinson & Imbeau, 2010). Use of the eSpark program in the treatment classrooms, as opposed to the general use of iPads in the comparison classrooms, impacted grouping practice in three of the six (50%) treatment classrooms, but the result was not the same. The remainder of the teachers in both groups did not change their normal grouping practices. For these nine teachers, those who reported grouping students prior to the pilot continued to do so. Teachers who did not routinely group students did not change their practices; although, six (50%) of the 12 teachers—three in each group—reported that students would occasionally "self-group" after discovering others with the same challenges.

The one teacher who mentioned using *more* grouping due to the eSpark process was a treatment teacher. She reported grouping the students a "little better and more frequently." For her, the eSpark process and related challenges helped her understand who had or had not mastered the learning objectives, which actively influenced how she grouped students.

Two other treatment teachers reported *less* grouping when using eSpark. One noted that the students worked more independently since they all had personalized challenges. Another treatment teacher noted that she eventually grouped students less frequently because they talked too much, so she began placing them next to students who did not have similar challenges or apps.

Another common indicator of differentiation is that the instruction is modified to meet the needs of individual students by accommodating student learning styles, interests, and prior knowledge (Logan, 2011). Teachers were asked whether the apps allowed students to learn "in a way they liked to learn." Overwhelmingly, all of the teachers reported strong agreement that the apps helped meet individual student needs. This was consistent in both the treatment and comparison groups. Teachers noted that the students "loved" the apps or thought they were "cool." Most noted that the students would spend more time with the apps, even though some were similar to print-based activities, such as flash cards. Other benefits of the apps included the teachers' ability to provide feedback to individual students and the students' ability to work on challenges alone without having other students know what they were working on. One treatment teacher reported that she expected the novelty of the iPads to wear off but that "it never did." An exception was with two special education students in one treatment class who either did not prefer using the iPad or did not stay focused when using it.

Modifying or adjusting content to meet the needs of students is another hallmark of differentiated instruction. While the content may vary, the students still work towards mastering required standards or learning objectives (Anderson, 2007). The nature of the eSpark program is that students work on different content but target similar standards if they have the same learning goals. To determine how well the program supported this type of differentiation, teachers were asked if the apps provided students with the necessary content to master individual learning goals. There was general agreement amongst the treatment teachers that the apps provided appropriate content to individual learning targets, with only one or two individual apps standing out as not being well aligned or lacking relevant instruction. One treatment teacher noted that some of her seventh-grade students had a hard time making a connection between using the apps and "learning to read." Another noted that eSpark staff were helpful in adjusting the apps or the pace of the challenges, if necessary.

The comparison teachers did not have access to the eSpark app; although, some used many of the same or similar apps as the treatment group—minus the analysis of student data and the setting of learning goals, which are included in the eSpark process. Because of this, several comparison teachers reported some difficulty in finding appropriate apps. One mathematics teacher wanted access to additional apps related to measurement, while another wanted apps that addressed more higher-order skills. One teacher relied on the division ITRT to find additional apps.

Supporting Instruction with Apps

When asked how their instruction might have been different when using the devices, teachers in the comparison group reported more differences than the treatment teachers did. As noted previously, one treatment teacher reported more grouping when using the eSpark app, and two said that the students worked more independently during these times. Teachers in the treatment group also mentioned spending more time monitoring students and managing the process, especially providing technical support. Treatment teachers reported providing technical support almost exclusively over instructional support. One treatment teacher reported that her students appeared more confident and that while they would have liked "free time" with the iPads, their work seemed to improve just knowing that it was directly tied to learning and assessments.

Teachers in the comparison group provided more indications of changes in classroom practice, such as using fewer worksheets, more student practice opportunities, and more individual attention. One comparison teacher reported changing her 45-minute class to provide more opportunities for independent learning rather than teacher-directed instruction—sometimes giving students the choice of selecting their own apps or using apps as an introduction or follow-up to instruction. Two comparison teachers reported using the iPads as a reward for completing other work—as long as the minimum 90-minute-per-week requirement had been met.

Treatment teachers expressed significant agreement that the challenges selected for students through the eSpark process seemed mostly accurate. Teachers reported sometimes making minor adjustments to the challenges for some students. Two treatment teachers noted that while the alignment of the challenges through eSpark was accurate for the different learning needs of her students, the challenges did not always align with the topic of instruction planned for the week—one added that it did not match her pacing guide.

Teachers in the comparison group had to determine on their own how to assign apps to students. Teachers reported many different strategies, including the use of iPads in center-based activities or whole-group instruction on a single topic, or by allowing students the freedom to choose their own apps. Several teachers identified apps ahead of time and allowed the students to choose. Three comparison classrooms had access to the same apps as the treatment classroom in their division. One comparison teacher reported that it was difficult to find appropriate apps at different levels, so she did not differentiate the use of the apps. In her classroom, all students would work on the same app at the same time based on the lesson being studied. In one division, the school's ITRT identified relevant apps and organized them in folders by topic.

In terms of technical issues, students from several groups reported "missing" apps. It is unclear whether these apps were truly missing or deleted, or whether the students lacked the skills to find them, possibly because the apps appeared in different places or looked differently when updates were made. It is possible some of the apps could appear to be missing after incorrectly synching the device, but since all apps were linked to iTunes accounts, these issues would have been easily resolved. As one student reported, "I couldn't find a song I was supposed to do, but one day, when we got our iPads back, I went looking for it and I found it." In the case where an app was

recommended for a student but the division had not purchased or installed it on the student's iPad, students could skip an app if they didn't have it. Students in all groups reported that if they had a problem, they usually raised their hands to inform their teachers.

Student reactions

Student reactions to the devices and apps in both the treatment and comparison classrooms were very positive. The word "fun" was mentioned repeatedly by students in almost all interview groups. Students reported that they enjoyed playing the games; one student calling them "learning games," and several said they enjoyed reading stories on the device. Based on the teacher interviews, the students enjoyed using the devices and apps and were noticeably engaged and excited to be using them. When interviewed, ITRT who observed both treatment and comparison groups noted that the students seemed to be more engaged; one ITRT reported that the "engagement really increased," while another stated, "Every time I went in the class, the kids wanted to share what they had been doing with the apps."

Students reported they had little problem operating the gesture-based devices or the apps, with one second-grade student reporting, "We know better than the teachers." Several students reported that relatives had iPads or iPods, so they were used to them. Two groups specifically mentioned that the onscreen keyboard was easy to use, but one student reported not liking the challenges because they "made me type in too much." Some reported that the apps were challenging in terms of content knowledge or skills but not in operation. Some enjoyed the video challenges, but several mentioned that completing the video "made them nervous" or that they were embarrassed; however, there was agreement across all the student groups that basic operation of the device was easy.

Some teachers noted that the apps benefitted students at both ends of the performance spectrum—high and low achievers—while others noted challenges for both groups. In terms of higher-performing students, one teacher noted that these students became more independent in their learning, while another noted that these students often became leaders who showed other students how to use different apps. In contrast, one teacher noted that her higher-performing students sometimes became frustrated when they had to repeat a challenge due to poor performances. The vocabulary and directions for some of the apps was a challenge for some students, especially struggling readers. One teacher noted that her struggling students tended to be the best motivated when using the apps.

No teachers reported any behavior problems related to the devices, whether in the treatment or comparison classrooms. Using the device and related apps in either setting appeared to be motivational for many students. One teacher reported threatening an iPad "time out" if the students misbehaved; her students perceived this as a "horrible punishment."

Several teachers reported success stories for individual students who had previously struggled with different content-based skills. Two mathematics teachers—one in a treatment classroom and one in a comparison classroom—reported that the devices and mathematics apps had positive benefits on instruction. Both noted that the students seemed to be more "excited" about mathematics, one saying she "would have a hard time keeping them excited about math if it were being taught in a more

traditional way." Some teachers noted that the students seemed to make greater connections between mathematics and other subjects or settings.

Teacher anecdotes: The following are quotes from the interviews with treatment teachers who had access to eSpark.

In one classroom, the teacher noted that her students generally hated doing language arts sequencing exercises, but the apps presented the material so that it was interesting and fun. "If I had given them worksheets they would have been complaining, but working on the apps gave them the practice they needed without seeming to be 'work.'"

In an older math class, full of students who struggle every day in school, the teacher saw her students grow "in confidence in their math skills. Using the iPads have made them feel special and this is a positive sort of 'special.'" One student had a very positive experience because of the privacy of working on her own skills development at her own pace without being 'visible' to all the other students. This same teacher was also able to leverage the video challenge that students completed into helping them learn soft skills, such as pre-planning, that they don't normally get.

A second grade teacher who was focusing on math skills felt that the apps helped her learn what the students had learned in her lessons. "I was able to group them a little better and more frequently. Telling time, for example, I could really know that this group of 3 or 4 totally got it and could do more advanced time differences. Or, in one case, I had 6 or 7 kids who were still barely getting the minute hand, so I could keep them together for a while. That would have been way harder to tell without assessment/apps." All of her students, from gifted to special education students, were sad when math class was over. She found that they all like math as a subject much more now; she felt she would have had a much harder time sustaining the enthusiasm by teaching in a more traditional way.

"(U)sing eSparks really helped me let the kids use technology more independently [because] they felt confident that they were doing the right thing—as opposed to doing apps just in general." The teacher noted that although kids claim they like "free" time best, they really loved having the structure that the eSpark app supplied. They liked knowing that what they were doing was connected to how they had been assessed, that the apps were helping them work on their own specific needs. This second grade teacher used the Teacher Dashboard to keep an eye on the progress of her students. "Many of the students who would not even complete a worksheet on a topic would definitely complete the iPad app activities." She found that students who could not engage unless she was right at the table with them had no problems when they were on the iPad.

Support for Teachers

All teachers in both the treatment and comparison groups reported ample support for the project. Many relied on internal technical support—a school or division ITRT or other technology support personnel—especially for issues related to setting up the iPads or installing the various apps. Several technology support personnel reported that they and their support staff would have benefitted from professional development regarding the device itself so they could have better supported teachers; however, the teachers at all schools praised the internal support they received. Because of the availability of on-site technical support, few treatment teachers reported using the eSpark Control Center (help line), but those who did reported being satisfied with the help they received.

Technology support personnel noted that the teachers need a bit of help at the beginning of the project—"just what you'd expect" when getting started with a new device. One ITRT whose teachers had to share one set of iPads noted that if technological problems would arise, ITRT might not always be available to solve the issue in a timely fashion.

Technology support personnel reported helping some teachers look for appropriate apps; however, they felt that managing the installation of the apps was their biggest concern. Some noted that teachers wanted to differentiate their purchases—buying a variety of content apps at different levels to match the ability levels of their students—but this was difficult logistically. One confirmed that instead of buying a limited number of three different apps at different instructional levels, the school would purchase and install all three apps on each student device. In schools with a limited number of devices shared across classrooms, managing the availability of the devices (through a sign-up process) was important.

One teacher noted that her students had to share headphones, which had to be cleaned after each use, causing lost instructional time. Another teacher reported that although every student had his or her own designated set of headphones, she had to be sure each student received the correct set, which also took some time.

Some of the technology support personnel reported concerns about replicating the process in the future. There was some confusion about whether the eSpark app could be reused with different students, but a greater concern could be how to organize and manage all the other apps.

Several teachers relied on others, including a reading specialist who was always present in the classroom when using the eSpark app. One comparison teacher noted that without the technical support she received, she would not have participated. Several other teachers indicated that they would have liked to have had an additional person in the room during instructional time with the devices.

A couple of teachers mentioned supportive administration. One treatment teacher noted that not only was her administration interested in the pilot but that her administrators "did not criticize that her class was doing things differently from a 'normal' class."

Two treatment teachers suggested they would have liked to have been more familiar with the apps selected, the content and activities these apps included, and the program itself. One treatment teacher who did not attend the professional development prior to the pilot noted that she felt "removed from the content" because she had not previously read or used the app content. She provided some suggestions for additional support, such as summaries for the longer reading materials, multiple-choice items that provide immediate feedback to the reading activities, and directions for guiding students who answer questions incorrectly.

Meeting the Goals of eSpark

The aim of eSpark is to differentiate instruction so students can receive instruction and support on the skills and knowledge they most need, based on input from test data and teachers. The teachers in the treatment classrooms and their corresponding technology support colleagues were specifically queried about how well the pilot had supported this goal.

As mentioned earlier, the eSpark process does provide different challenges to students based on assessment data and personal learning goals, which assist in adjusting content and processes. In this pilot, students received different content in their challenges, and the varied apps provided different types of learning activities to adjust processes.

Teachers in the treatment group confirmed that the eSpark process worked well overall. With few exceptions, they reported that the challenges matched the abilities and interests of the students and aligned with personal learning goals. Some students struggled with vocabulary and the complexity of directions for some apps, but it should be remembered that most of the students were in the second grade. Also, students in higher grades were in remedial classes. Technology support staff confirmed that the process seemed to work well, calling the alignment of challenges to student learning goals "great." They, too, echoed the concerns that some vocabulary and directions were difficult for students.

One of the challenges of differentiating instruction is that students often work on different content at different levels and at different times. This can be a challenge to coordinate. Teachers in the treatment group noted that the students adapted very well to the differentiation process. There were few negative reactions generated by students working on different content than others; some teachers even saw this as something positive, especially since the students worked independently and did not have to share what they were working on with others—only the teacher had to know. One teacher did note that management was more difficult because she was not always aware when a student was off task, but another reported using the eSpark Mission Control to keep track of individual student progress.

Teachers reported little use of the eSpark Mission Control during the interviews. Those who did, however, used it to help determine student progress and whether the challenges were at an appropriate level—what might be considered an indication of appropriate differentiation. One teacher reported that the eSpark Mission Control was time consuming and that she rarely had time to use it because she was busy providing support to students. On the other hand, one teacher reported

using the eSpark Mission Control extensively and found it helpful. She appreciated the addition of the mood icons for student use and reported that her students liked to use them. Two teachers requested that the eSpark Mission Control interface generate additional reports: (1) at "the activity level, rather than the challenge level, so students could be monitored on a particular skill," and (2) another showing some type of mastery of tasks. Staff at eSpark confirmed that teachers can use the interface to drill down and see the number of challenges each student has completed, the outcome questions they were presented with, and their answers; however, the system does not currently create a student or class report that can be easily printed or exported for grade reporting.

In terms of adjusting products—another characteristic of differentiated instruction—the final eSpark challenge in a quest is always a student-generated video. Students have some flexibility as to what they record, which differentiates products, but this video component garnered the most feedback in terms of difficulty for students. Some teachers—all second grade—reported that while a few students could develop the videos on their own, it was a challenge for most. The teachers reported that some students required instruction on creating videos and that others did not know how to answer the questions asked of them. For example, one question asked students to "summarize," which was confusing until the teacher informed them they had to "retell" the story in their own words.

In terms of processes, some teachers allowed students to create their videos in the hallway or a classroom space specifically set up for recording. One teacher, who was enthusiastic about the videos, noted that while she thought the culminating video was helpful, she had to be present while her second-grade students recorded their videos. Once recorded, all teachers agreed the products demonstrated student understanding of content.

Several teachers suggested additional ways to assess students besides videos, thus increasing opportunities for differentiating student products. These suggestions included adding options of drawing pictures, writing answers, completing questionnaires, or otherwise completing more traditional assessments. Two teachers mentioned that additional feedback from the eSpark app would have been beneficial to students, primarily by providing them with immediate feedback.

There may be some existing logistical/programming difficulties, as students sometimes open separate apps for challenges and basic instruction and then return to the eSpark app to answer questions. Student responses are recorded in the eSpark Mission Control but not in the student app itself.

Student performance measures

Mathematics

Since categorical data were collected on the assessments, statistical analysis of the test scores was not possible. Instead, the percentage of students at grade level on each strand was calculated. The grade level was set as a score of 2.5 or above on individual assessments because the pilot occurred approximately midway through the year, and all students who completed both tests were in the second grade. Both the treatment and comparison groups showed an increased percentage of students on grade level for all strands on the post-assessment compared to the pre-assessment. Based

on these assessments, the mean number of students at grade level for all strands was calculated and compared for both groups.

While the comparison group showed an increased percentage of students on grade level on the individual post-assessments (see Table 2), the overall change from pre- to post-assessment for this group was not statistically significant—likely due to the lack of change on the fractions subscale. The treatment group (see Table 3), however, showed statistically significant gains from pre- to post-assessment in terms of mean percentage of students at grade level across all strands (p=.02), likely due to consistent increases in the percentage of students on grade level on all three strands. Despite a focus on measurement in the eSpark treatment, the comparison group saw more growth on this subscale. The primary difference between the two groups from pre- to post-assessment was on the fractions subscale, which was not a focus of eSpark. No students had a learning goal focused on fractions. This suggests that the measurement instruction may have helped students better understand fractions as well.

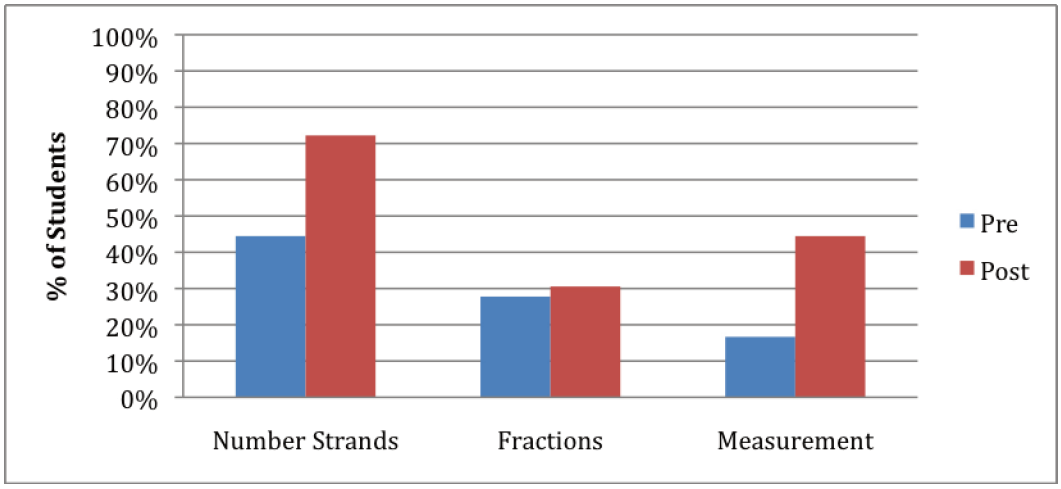

Table 2. *Students at or above grade level in mathematics in the comparison group*

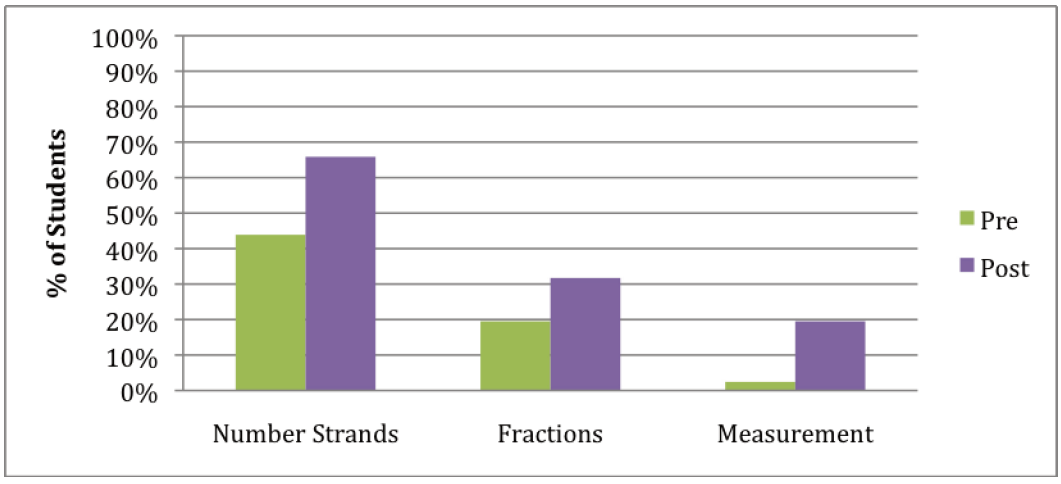

Table 3. *Students at or above grade level in mathematics in the treatment group*

The percentage of students with improved scores was also calculated for all strands for each group. This calculation considered only whether the students' post-assessment scores were higher than their pre-scores, regardless of whether they were on grade level. A greater percentage of students in the treatment group improved their scores from pre-test to post-test than in the comparison group on two mathematics strands: fractions and measurement (see Table 4). The mean growth for both groups across all subscales, however, was 58%; thus, the overall mean difference in growth between the two groups was not statistically significant.

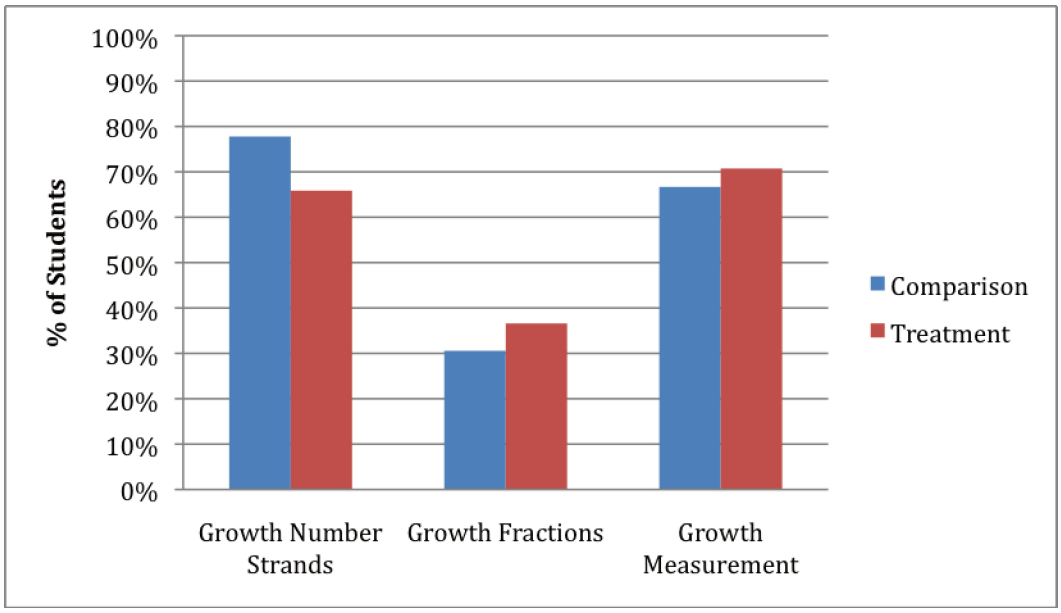

Table 4. *Improved scores from pre- to post-assessment in mathematics*

Reading

Similarly, due to the type of data collected on the assessments, statistical analyses of the test scores were not possible. Instead, the percentage of students at grade level on each strand was calculated (grade level set as 2.5 or above). In the reading strands, both groups showed statistically significant differences in the mean percentage of students on grade level (grade level equal to or greater than 2.5) between the pre- and the post-assessments (see Tables 5 and 6). There was no statistically significant difference between the comparison and the treatment groups on the post-assessments, suggesting that the instruction in treatment and comparison classrooms was equally effective for this particular set of assessments.

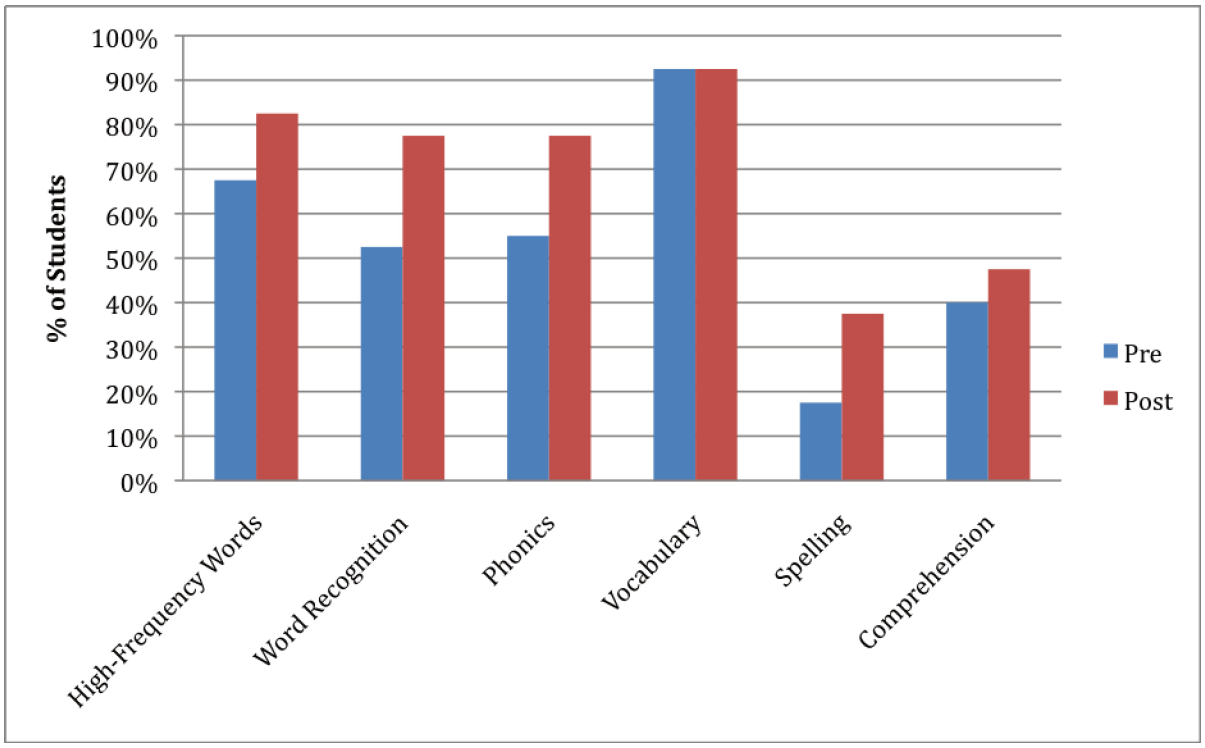

Table 5. *Students at or above grade level in reading in the comparison group*

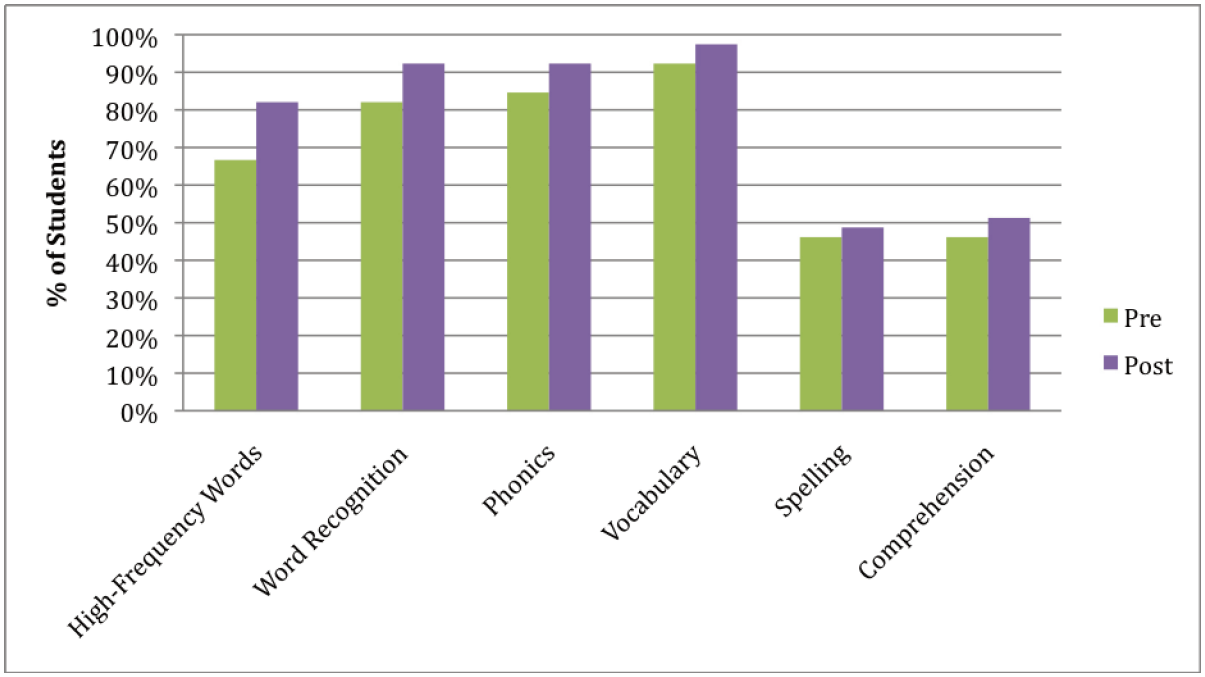

Table 6. *Students at or above grade level in reading in the treatment group*

Note: On the Phonemic Awareness assessment, there were no students in either group on grade level. As a result, this is not included in this chart.

With respect to the percentage of students who were on grade level from pre- to post-assessment, both groups increased on all reading strands except Phonics. The comparison group showed the greatest increase in Word Recognition, while the treatment group had the greatest increase in High-Frequency Words. Neither group showed any change in the percentage of students on grade level on the Phonemic Awareness strand since no students in either group were on grade level on this assessment. Validity studies conducted by the publisher have indicated potential problems with the reliability of this assessment, which may be the cause of these low scores.

The percentage of students whose scores improved between the pre- and the post-assessment was also calculated for all strands for each group (see Table 7). On five of the seven strands, a greater percentage of students in the comparison group improved their scores than in the treatment group. The percentage of students improving their scores from pre- to post-assessment in the treatment group ranged from 31% on Phonemic Awareness to 69% on Word Recognition. For the comparison group, the percentage of students improving upon their scores ranged from 37% on Phonemic Awareness to 68% on Word Recognition. The differences in growth between the two groups on the seven reading strands was not statistically significant.

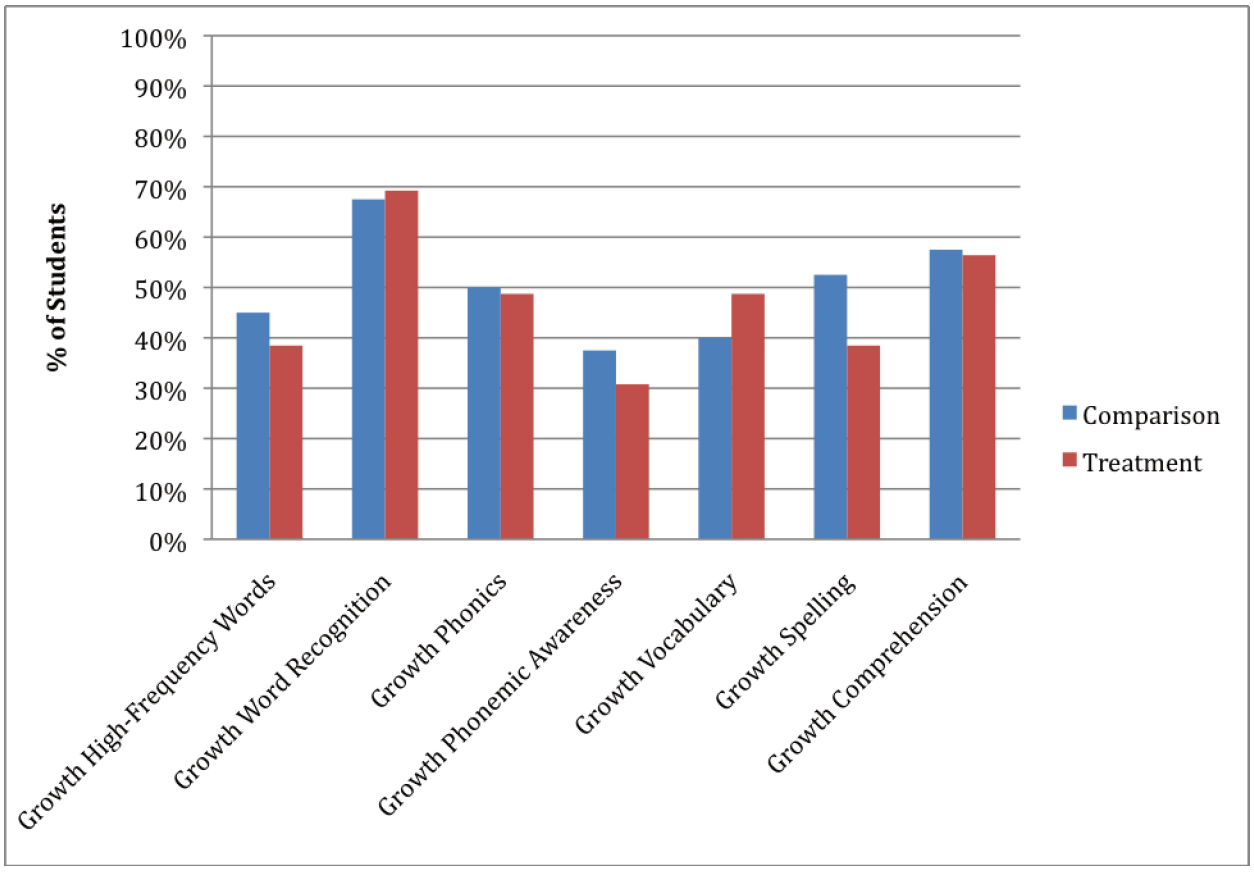

Table 7. *Improved scores from pre- to post-assessment in reading*

FINDINGS

The following interpretations and recommendations are based on these data and the evaluation questions. Recommendations are just that and are intended to help educators and curriculum resource developers consider how the eSpark app and process, and similar products, can support differentiated instruction, provide the required support, and potentially impact academic achievement.

Interpretation

Fidelity. Most teachers reported background knowledge and skills in differentiated instruction and varied levels of institutional support. Several noted that their school or division emphasized differentiated instruction and that they used curricular materials designed to support differentiated practices. However, when describing actual classroom practices, not all of the teachers indicated incorporating strategies common to differentiated instruction models, such as using different grouping strategies or adjusting content. One teacher misinterpreted the term.

Recommendation

The term *differentiated instruction,* like many terms in education, can be misunderstood or may be recognized but not matched with deep understanding. Knowing the term itself is not as important as understanding and implementing appropriate strategies and materials with fidelity for any instructional intervention adopted by a school. When considering the adoption of curricular materials, like eSpark, teachers and school leaders should understand how they match current or desired practices or expected outcomes. Resources intended to change practices may require additional preparation and time to implement and additional support while being implemented. The potential benefits of the most promising practices are the impacts on student achievement. Teachers and school leaders will need more than a surface-level understanding of any intervention and will have to know what it looks like in practice, how it should be supported, and potential outcomes for both full and limited implementation.

Interpretation

Student grouping. Use of the eSpark app impacted the grouping of students for instruction in three of the five (60%) treatment classrooms. Having access to the device and apps without the eSpark app apparently did not change teachers' groupings of students for instruction. The impact was not the same in all three classrooms, as one teacher reported grouping students more often and changing groups based on feedback from student data captured by eSpark. Two teachers reported grouping students less but using individual rather than whole-group instruction because the eSpark quests were individualized to students.

Recommendation

If student grouping is a desired outcome, additional consideration may be given as to why only one teacher found support for changes in grouping when using eSpark. Combined with the low use of the eSpark Mission Control, consideration should be given as to whether the other teachers realized the benefit of the data provided to teachers in support of grouping. Support in the form of additional professional development or a review of the teacher interface could be required to encourage teachers to use the data to support grouping, if desired.

Individualizing instruction and content are also common differentiated strategies that can be difficult to implement and should not be discounted in those classrooms that incorporate more individualized, rather than small-group, instruction. The eSpark process may allow teachers to differentiate instruction through individualized learning.

Interpretation

Managing differentiated practice. Students working at different levels on different content and creating individual demonstrations of learning can be challenging. Teachers reported that the students adapted very well to the differentiated practice and did not report any concerns about not working on the same content as others. Some students actually saw this as a benefit because they felt secure knowing they were working on content picked just for them—no one else but the teacher had to know what they were working on.

Recommendation

The misunderstood concept of "fairness" equating to every student working on the same content at the same time is something differentiated instruction experts suggest teachers have to overcome. This is an accepted process, however, when teachers are encouraged to implement a "standard" curriculum. According to differentiated instruction experts (Wormeli, 2003; Tomlinson & Imbeau, 2010), fairness does not mean doing the same thing at the same time, which can actually be counterproductive to learning, but providing the appropriate content to students at a level they need and want. Indications are that the eSpark process provides appropriate content to students at a relevant level of challenge, which supports differentiated practice.

Interpretation

Changes in practice. Teachers in the comparison group related changes in classroom practice more often than teachers in the treatment group. One reported changing the structure of her 45-minute class to provide more opportunities for individualized learning rather than teacher-directed instruction. Other teachers noted using fewer worksheets and more opportunities for students to practice skills.

Recommendation

The eSpark process provides a comprehensive instructional cycle, incorporating diagnostics of student performance, setting learning goals, aligning student content to those goals, and having students demonstrate mastery. Perhaps because this process includes a complete instructional cycle, as opposed simply to integrating apps when available, teachers using eSpark found ways to incorporate it into their teaching routines. If not implementing a complete instructional cycle, educators may give some consideration as to how similar devices and apps may impact practice when introduced and whether existing practices will support their integration or make new instructional models easier to implement.

Interpretation

Technology as a reward. Two of the comparison teachers reported using the iPads as a reward for completing other work.

Recommendation

Using technology or other desired resources or activities as a reward changes the motivation of students and shifts goal attainment from learning outcomes to outcomes that relate to behavior or competition (Dweck, 1986). When selected to meet student learning goals, all students should be given an equal opportunity to access the curriculum by whatever means is helpful, such as using appropriate technologies. Perhaps not having the eSpark structure in the comparison classrooms prevented these teachers from shifting the technology use from a required learning support to a reward for behavior.

Interpretation

Meeting individual student needs. All of the teachers noted that with the exception of two special education students, the apps used in both the treatment and comparison classrooms met individual student needs. Students willingly spent more time using the apps as compared to other forms of instruction—even when the activities were similar in process and content. The immediate feedback the apps provided to students was identified as a strength for supporting individualized student learning.

Recommendation

App-based learning in which students receive immediate feedback may be implemented successfully in classrooms to support differentiated instruction. Some students may need alternate means of instruction—which is often the case in a class that incorporates a differentiated instruction or Response-to-Intervention model—and could be accommodated in these settings.

Interpretation

Finding apps. Some of the comparison teachers noted that while the apps were positively received, finding appropriate apps could be difficult and time consuming. One teacher reported not differentiating which apps she used but required all students to work on the same app at the same time. One relied on technology support personnel to find apps. Some teachers in the comparison group chose a limited set of apps. Three of the comparison teachers had access to the same apps as the treatment classrooms.

Recommendation

The eSpark process may be a benefit for teachers seeking to find relevant and appropriate educational apps from the many thousands now available. Teachers and curriculum specialists who want to support differentiated instruction by implementing app-based learning may benefit from the eSpark process because it saves time and effort in terms of finding appropriate apps that match with student needs.

Interpretation

Familiarizing teachers with apps. Two teachers in the treatment group suggested they would have liked to have been more familiar with the apps and the content they included. Because the eSpark process identifies and selects apps for the students, teachers could have students working on dozens of different apps at the same time, and teachers did not have enough time to preview all of them prior to or even during the pilot. One teacher suggested that having summaries of some of the longer reading materials would have been helpful.

Recommendation

Based on comments from the one teacher who missed it, a professional development session prior to adopting the new process would have been helpful; although, one session alone may not be sufficient to familiarize and keep teachers current with apps selected in the eSpark process. This could be an ongoing issue as new apps become available often and can be reviewed and subsequently adopted by eSpark. The benefit to teachers is that someone else does this review. Teachers already have limited time to review curricular materials, and, while online supports in the form of review sites are available, some consideration may be given to providing incentives or encouraging participation in online communities as a way to help teachers become more familiar with the apps and related pedagogies and management strategies. eSpark has proposed such a community composed of other

eSpark teachers. eSpark staff may also give some consideration to providing teachers with some sort of summary of selected apps, perhaps provided to teachers when the apps are identified or made available through connections to the teachers' profiles in the eSpark Mission Control. Creating summary information may not be difficult, but providing it in an easily accessible format to teachers will be important.

Interpretation

Alignment of instruction. The treatment teachers reported that most of the apps selected through the eSpark process, with a few exceptions, provided instruction and practice that matched with individual student learning goals. Students who did experience some mismatches—challenges being either too easy or too hard—could have their challenges adjusted through contact with eSpark personnel. Teachers could also make these changes themselves through the Mission Control interface, but no teachers in the pilot reported doing this.

Recommendation

According to the teachers and technology support personnel, the eSpark process individualizes instruction and content for students. As in all classrooms that adopt differentiated strategies, some students may work on the same or similar activities at the same time, but the overall profile of instruction for each student will be relatively unique. All agree that there was a high degree of match between the challenge of the instructional events and student needs.

Interpretation

Alignment to curriculum. Two teachers noted that while the apps were appropriate to student needs and matched their targeted learning goals, the content did not always correspond to their planned instruction or pacing guide.

Two teachers mentioned support from their administration for the pilot, and one treatment teacher noted receiving no criticism for her class not looking like a "normal" classroom.

Recommendation

Schools and divisions develop teacher guidelines, such as curriculum maps and pacing guides, to help meet overall curricular goals. Generally, these supports encourage teachers (intentionally or not) to present all of the content in a yearlong curriculum regardless of whether the students are ready for it or may have already mastered it. When implementing differentiated instruction, as supported by the eSpark process, consideration should be given to being more flexible with guides, such as curriculum maps and pacing guides, and focusing more on student mastery of the skills and knowledge included in those guides. This can be a challenge to manage and requires support from school leaders and curriculum specialists. Matching student achievement data to desired learning outcomes may be a good step for managing this differentiation, but if all instruction does not have this level of data to support curricular decisions, it can be difficult for teachers to prepare and deliver appropriate instruction. Ultimately, they may fall back on more structured approaches simply to make instructional development and delivery manageable. Long-term solutions may include alternate forms of student grouping and teacher assignment to students and the incorporation of additional measurements of student data and matching curricular resources.

Interpretation

Instructional support. As might be expected when incorporating new technologies, teachers reported increased time monitoring student use and conducting basic technical support and troubleshooting. Teachers reported providing more technical support than instructional support to students, which may indicate that students had more issues operating the devices than they originally considered.

One teacher had a reading specialist available during eSpark instruction time, and others mentioned the availability of technical support personnel. Several teachers reported that they would have liked to have had additional instructional support, perhaps to spend less time on technical support and more time on instructional support. In both the treatment and comparison groups, the presence of the ITRT was an often-mentioned positive form of instructional support.

Recommendation

Schools may not have the opportunity to provide additional instructional support when implementing a new technology-based process like eSpark, especially if the technology-based solution provides instruction at some level. Schools may want to consider models that offer additional support to teachers when initially implementing a program like this or that consider alternate grouping strategies that allow teachers to combine students across classrooms during instructional time. Schools that do not have the benefit of an ITRT or similar instructional support staff should consider other models of support when implementing new technology-based services.

Interpretation

Student ability to use the device and apps, generally. Students reported few or no problems using the devices or the apps, but teachers did note that they spent most of their instructional time on technical issues. Some students in the treatment group reported that the apps selected for them could be challenging, but this comment was more likely attributed to the content skills required, not basic operations. Teachers reported that some students got frustrated when they did not complete a content challenge with appropriate accuracy, indicating that the instruction may indeed have provided an accurate level of challenge for students at different levels.

Recommendation

Considering that most of the students were in second grade, the gesture-based interface of the Apple iPad apparently was easily understood and operated by many students. Any devices selected for student use should be easy enough to use so that students can focus on instruction and practice to master learning goals rather than having the technology be a barrier to learning.

Interpretation

Student ability to use the eSpark app. Teachers reported and technology support staff confirmed that some students struggled with the vocabulary and directions in some of the apps and challenges. This was true for the second-grade and some of the older students; however, the fifth- and seventh-grade students were in remedial classes—one in remedial reading—so, it is likely that all could not read on grade level.

Some students reportedly struggled with making connections between the apps and the feedback and questions asked of them in challenges. This is because the eSpark app connects to third-party apps that were not originally conceived or developed to be connected in such a way.

While students apparently could operate the eSpark app, consideration should be given towards providing support for vocabulary and making directions clearer. This may be especially helpful for students performing below grade level. When issues with vocabulary and directions occur in third-party apps—as opposed to the eSpark app—some consideration should be given as to whether this might disqualify an app from selection. In some situations, a crosswalk or additional guidance within the eSpark app could be helpful, but doing this for a large number of third-party apps could be prohibitive.

Consideration should be given to allowing teachers a quick way to provide eSpark with feedback on issues such as difficult vocabulary or confusing directions on specific apps. This could help focus eSpark's efforts to improve the system since not all challenges or third-party apps contain these issues. If this feedback mechanism already exists, teachers may not know it is available and may need additional information about how to provide this feedback. If it does exist, eSpark should address how easy it is for teachers to use.

Interpretation

Student engagement and motivation. Teachers and students in the treatment and comparison groups reported that the devices and apps were positively received. Teachers and technology support reported that students were often engaged and that some were more willing to work on activities or work longer on activities when using the technology. Teachers reported that the technology motivated students at both the higher and lower levels of achievement. Teachers reported no behavior issues when using the devices; although, one treatment teacher had to reorganize her classroom seating arrangement to cut down on talking—perhaps prompted by student excitement—when using the eSpark challenges.

Several teachers in both groups shared stories of individual students who achieved notable success when using the devices. These were related to overcoming both personal and content-specific behaviors the students had exhibited prior to the program. Two teachers reported that their students appeared to be more excited about mathematics—even during other mathematics instruction—after being exposed to the devices. One noted that the students appeared to see greater connections between mathematics and other areas.

Recommendation

Teachers wishing to implement technology devices and apps similar to those used in the pilot should be encouraged that they could motivate and engage students. This finding is probably most applicable to second-grade students due to the small sample size of the fifth- and seventh-grade classrooms; although, similar benefits were noted in those classrooms.

Additional expected benefits may be similar to those purported by differentiating instruction, such as providing instruction at appropriate levels of challenge, making instruction and learning more relevant to students, and providing ways for students to make connections with other disciplines.

Interpretation

Video challenges. The teachers generally perceived the student-created videos—as a way to demonstrate learning—as a positive, but some students had difficulties with both the process and the technology. Some students reported being embarrassed or nervous when creating the videos. Several did not want to be on camera. Several teachers noted that the students required explicit instructions

and ongoing support on operating the iPads to capture video. It must be remembered that most students in the pilot were in the second grade.

Several teachers noted that they set up a special place in the classroom for recording videos or let students record videos in the hallway, where there were fewer distractions.

Teachers recommended additional options for assessment, such as drawing pictures, writing an answer, or completing a questionnaire or more traditional assessment.

Recommendation

Consideration should be given to providing means other than student-created videos to demonstrate learning. Different alternatives would support the notion of differentiating student products—an important aspect of differentiating instruction (Anderson, 2007; Tomlinson et al., 2003). While the videos were perceived as valuable, many students reportedly struggled or felt uncomfortable with creating them, thus making the videos a barrier to demonstrating learning. At the least, explicit directions to assist teachers and students with this component could be helpful. In addition, templates for or examples of students creating videos also could be helpful.

The apps and functionality of the iPad or other productivity apps could be incorporated into the system. Options include taking pictures and editing them, creating presentations and documents that include text and images, recording audio alone, completing surveys or questionnaires, creating a concept map or graphic organizer, or accessing Web-based assessments that may rely on forced-choice or open-ended assessment formats.

Interpretation

Technology support. All teachers expressed that they received ample technology support from their schools or divisions in terms of setting up the devices and implementation. One technology support person noted that she had wanted to be more readily available during the day when the app-based instruction occurred; however, no teachers identified a lack of technical support as an issue. One comparison teacher noted she would not have participated in the project without the internal technology support she received. Some technology support personnel reported that they would have benefitted from additional professional development on implementing and managing the devices prior to the pilot.

Recommendation

Schools or divisions interested in implementing this or a similar technology-based instructional intervention should confirm that they have adequate technology support prior to and during the project. Schools in Virginia benefit from the inclusion of ITRT in schools (or at least in divisions and shared across schools), but, even then, technology support staff could benefit from additional professional development or training on any new devices and processes, especially from a management perspective. This additional training may not be as necessary over time as devices such as these become more common in schools and as the hardware and software that manage the devices become more readily accessible.

Interpretation

Installing and managing apps and devices. The biggest technical issue identified was installing and managing apps, especially since the process requires the individualization of apps for different students. Some schools simply installed all the identified apps on all student devices, whether the students needed them or not. This was more costly, but installing a truly individualized disk image for each student could have been time prohibitive. The process was already time consuming, but support was provided by the eSpark team by installing and configuring the eSpark app on all of the student devices prior to the pilot and by providing follow-up phone and e-mail technical support. In one school with a single set of iPads, a scheduling system had to be established to ensure the devices were available for the comparison and treatment groups and for others who may have wanted to use them. eSpark is working on a solution to manage apps from third-party management solutions.

Recommendation

The device used in the pilot, the Apple iPad, was popular but still relatively new to our nation's classrooms. In addition, they are designed to be individual consumer devices, not learning supports for multiple users. Management applications for the devices are new in the market and require investigation and testing. However, because the disk images using eSpark can be different—because each student received different apps based on his or her profile, school officials must make decisions based on cost or time as to how the devices will be imaged.

Schools with enough devices for each student can avoid scheduling problems. Schools that allow students to bring personal iPads in a bring-your-own-device (BYOD) setting may have additional concerns as the responsibility for purchasing and updating apps falls upon families. Currently, this issue is time consuming and has multiple steps but will likely improve if the devices become more prevalent and if management software becomes affordable and useful.

Interpretation

Peripherals. Because apps often include sound, headphones (or earbuds) are required, but students should have individual headphones for health reasons. Ensuring that students received the correct iPad and correct headphones occasionally took up instructional time, as reported by two teachers.

Recommendation

Classroom teachers implementing devices that require headphones should establish procedures to ensure the equipment is distributed quickly and accurately. This may be easier with older students. It is recommended that each student have his or her own designated headphones or earbuds, and some schools may allow students to bring their own.

Interpretation

Teacher use of eSpark Mission Control. Most teachers in the treatment group reported little use of the eSpark Mission Control teacher Web site. One noted that it was time consuming and that there was not enough time to use it during class, perhaps because instructional time required more individual attention. The one teacher who used it extensively found it helpful and said she and the students enjoyed the mood icons. One teacher who did not attend the initial professional development did not access the Web site until late in the project but then noted it appeared to be beneficial and wished she had known more about it prior to the program. Two teachers requested that the Web site produce additional reports.

Recommendation

There was little feedback on the effectiveness or ease of use of the eSpark Mission Control. Additional information is required to understand the utility and effectiveness of these supports for teachers. eSpark may want to consider collecting additional data from teachers who use the system to determine whether the eSpark Mission Control provides all the required functionality, is easy to use, and offers necessary or helpful features, such as the additional reports recommended by teachers. Consideration should be given to incorporating student and class reports that can be formatted easily for printing or digitally for importing into grade-reporting systems. Periodic formative evaluation of the eSpark Mission Control teacher Web site is recommended as well as opportunities for current users to provide feedback immediately during use.

Interpretation

Academic achievement. The mean percentage of students performing at or above grade level on all mathematics areas increased significantly for students in the treatment classrooms. This mean percentage was significantly different from students in the mathematics comparison classrooms.

While the mean percentage of students performing at or above grade level in all reading areas significantly increased for both the treatment and comparison groups, there was no significant difference between the groups in terms of mean percentage of students whose scores increased between the pre- and post-assessment. The comparison group showed the greatest increase in the number of students at or above grade level in Word Recognition, while the treatment group showed the greatest increase in High-Frequency Words.

Recommendation

The significant difference in the percentage of students performing at or above grade level in mathematics is encouraging; however, additional studies would help determine if this growth is due directly to the eSpark app and process. A good place to start would be to analyze the app characteristics that help students produce higher gains.

While the percentage of students performing at or above grade level in reading was not significant between the treatment and control groups, those percentages did increase for both groups. Additional studies may determine more closely which apps are used in both settings, their characteristics, and actual practices in classrooms.

CONCLUSION

This pilot study investigated the potential of the eSpark app and process to support teacher efforts to differentiate instruction. Additional questions concerned how much support was necessary to integrate the eSpark app and process and the potential impact on student achievement. Most teachers in the pilot reported significant backgrounds in differentiated instruction, as evidenced through prior professional development. Several teachers also reported strategies, such as using flexible small groups, to support differentiated instruction. All teachers reported receiving technical and leadership support from their divisions for differentiated instruction; they also had some opportunities to modify their scheduling to meet student needs. Therefore, several conditions in support of differentiated instruction existed in the pilot divisions, preparing these teachers to adopt the technology-based resource.

Differentiation experts (Anderson, 2007; Petting, 2000; Tomlinson et al., 2003) suggest that teachers incorporate a variety of strategies and resources to differentiate content, processes, and products. Teachers and technology support personnel in the pilot agreed that the eSpark app provided differentiated content to students. One common barrier to differentiating instruction is the notion that it is not "fair" to give students different content, but this study confirmed the suggestions of many differentiated instruction advocates (Wormeli, 2003; Tomlinson & Imbeau, 2010) that fair does not equate to lockstep access to the same content at the same time. Instead, "fair" is more appropriately seen as providing the right content for each student when he or she needs it, and teachers in the pilot agreed that the eSpark app and process definitely provided this appropriate access to individualized content through the determination of individual learning goals and customized challenges for students.

Another aspect of differentiation is to incorporate content and activities that meet the needs of individual students in terms of learning styles, interests, and prior knowledge (Logan, 2011). All of the teachers agreed that the apps provided this level of differentiation, noting high levels of interest from almost all students in both the treatment and control groups and a willingness to use the resources for longer periods of time than other resources or activities. The treatment teachers added that the apps aligned highly with student learning goals and that things were easy to change, if necessary. The comparison teachers, however, indicated that it was difficult to find appropriate apps for their students. Some indicated that they would have liked to have had access to the eSpark app and process to take care of the time-consuming task of finding and reviewing apps and linking them to student learning goals. Some teachers in the treatment group simply did not look for apps and either used available apps or asked support personnel to find them.

Teachers also noted some differentiation of processes when using the eSpark app; although, teachers in the comparison group were more likely to change their practice in terms of grouping students—an indicator of differentiated processes. Some treatment teachers already reported using small-group instruction and continued to do so when using the app. One treatment teacher noted a significant change in her grouping practice due directly to the eSpark app. And, while the comparison teachers did note greater use of grouping in their classrooms when using app-based instruction, only the

treatment teachers noted reaching the point of completely individualized instruction, where each student worked on different content specifically selected for their needs. One comparison teacher noted she would allow students to select their own apps as a form of individualization, but their self-selection may not always have been matched to learning goals. So, while teachers in both groups conducted some small-group instruction to differentiate processes, only the treatment teachers reached the point of differentiating processes through individualized instruction based on student learning goals.

Each eSpark quest ends with students creating a student-generated video to demonstrate mastery. This was the most challenging aspect of the eSpark process for students, and the app's reliance on only one form of final assessment counters a basic tenet of differentiated instruction—differentiated products. Some additional assessment information was collected from students in the form of single responses to challenge questions, but these data are limited. Teachers suggested various additional methods for students to demonstrate mastery; eSpark should consider adding more types of final quests to truly differentiate instruction.

In terms of the primary evaluation question, the eSpark app and process apparently helped teachers differentiate instruction during the pilot. Use of the app-based instruction alone provided some indication of differentiation, but the use of the eSpark app and process allowed teachers in the treatment group to significantly and purposefully differentiate content and process, especially reaching the level of providing customized content matched to individual learning goals. Consideration should be given for providing additional means to differentiate product when using the eSpark app and process.

Both teachers and students reported using the devices and the associated apps. Student levels of confidence with the devices should be tempered by the fact that teachers had to provide students with a significant amount of technical support. Several students and teachers noted student difficulties in completing the video-based challenge eight in each quest. Teachers also had to help students make connections between the apps and related content and learning outcomes. Teachers who attended the professional development session noted it was helpful, but technology support requested additional professional development for their management and subsequent support for teachers using the devices.

eSpark staff provided ongoing support to teachers in the treatment classrooms through phone and e-mail. These teachers also reported receiving technical and pedagogical support within their divisions, particularly the assistance from instructional technology resource teachers (ITRT) in their school or division. Schools wishing to implement the eSpark app and process, or a similar product, should determine the typical levels of technical and pedagogical support their teachers receive and what level will need to be implemented. The teachers in the pilot also report receiving support from administration both for differentiating instruction and for incorporating these new devices. Administrators were encouraged to exercise some tolerance and flexibility in terms of curriculum pacing, pedagogy, scheduling, and even classroom layout.

One teacher who did not attend the initial professional development reported a disconnect with the content and did not use the eSpark Mission Control; however, they later found it to be helpful after a site visit from eSpark personnel. Technology support personnel did not receive professional development related to the devices or the eSpark app and process, and several suggested that this

would have helped them better provide pedagogical support when using technology. Additional support for technical support personnel could include providing additional training or incorporating a management system to better implement the many different apps so that they work is more efficient and the process is more cost efficient.

Few teachers reported using the eSpark Mission Control during the pilot. They were aware of its availability but spent more time providing support to students directly. Some found the data provided by eSpark Mission Control to be helpful, but only in a limited fashion. Teachers requested to have access to additional data reports, which are easy to generate and may be available in different formats. The limited use of the eSpark Mission Control could be due to different factors, such as inadequate exposure during professional development, a perceived lack of time on the part of teachers who focused more on working with students, or the lack of an easy-to-use interface for teachers. Additional studies are needed to determine how the eSpark Mission Control could be better utilized by teachers or made more beneficial.

In terms of the second evaluation question—identifying the nature of support required for teachers to differentiate instruction using the eSpark app and process—it appears an introductory professional development session was beneficial to those who attended, especially considering the reaction of the teacher who did not attend. Additional supports could include suggestions from teachers using the eSpark app and process, such as those that have emerged from this study. These suggestions could be incorporated into professional development offerings, support materials, or other collaborative efforts, such as an online community.

Additional consideration should be given to providing technical and pedagogical support personnel with professional development. Ultimately, schools or divisions could benefit from a management system that helps coordinate the purchase of diverse apps. As new software applications become more readily available, they should be easy to use and affordable. Until then, technology support personnel could be forced to make purchases that are more costly but more efficient to manage—such as purchasing apps for all devices in bulk regardless of which students need them.

Support for classroom teachers and for students is also necessary. While the teachers in the pilot had access to ITRT and administrative support, schools or divisions wishing to implement the eSpark app and process, or a similar one, would likely benefit from similar support structures. If ITRT or instructional technology support are available, they should be afforded adequate time to support the initiative. If these resource personnel are not already available, schools might consider establishing some type of technical and pedagogical support so the teachers can focus on classroom instruction rather than managing the devices.

In terms of classroom teaching, an increasing number of students can manage the basic operations of gesture-based devices like the iPad, but additional effort may be required to help them understand how the activities on the device relate to individual learning goals. When working with younger students, vocabulary and directions are more important; these should be appropriate to the ages and reading levels of the students.

For the final evaluation question, which examined student achievement, the percentage of students performing at or above grade level in both reading and mathematics increased for both the treatment and comparison groups. There was a significant difference between the treatment and comparison groups in mathematics. While this is encouraging, it is difficult to isolate all of the factors that could have led to this growth. Additional studies should record and analyze the resources and strategies employed by all teachers.

Literacy instruction is heavily emphasized in grades K-3. The eSpark process was just one activity that teachers used to address this subject. It must also be remembered that teachers in three comparison classes had access to the same apps as those in the treatment classes, which could skew the comparison; since the eSpark service reviews and identifies apps based on several criteria, these comparison teachers may have had access to more effective apps than if they had found them on their own.

In conclusion, the eSpark app and process appears to have supported differentiated instruction in the pilot classrooms. Its flexibility provided teachers with various methods and strategies to differentiate instruction in different classrooms. One of eSpark's greatest benefits is its efficiency and effectiveness for identifying educational apps and other resources for multipurpose portable devices—this process can be cumbersome, at the least, and potentially overwhelming for some teachers. Adequate technology support is required to implement the app and process, but the teachers and students showed great ease in terms of basic operations of the devices. Schools and divisions should provide adequate administrative and technical support, and teachers and technology support likely would benefit from professional development related to the app and process. The students using the app and process demonstrated improvements academically, especially in mathematics, but additional studies with a wider range of students could help better determine eSpark's potential impact on student learning.

APPENDIX

Questions for all teachers:

1. How much professional development in the last 5 years have you had relating to differentiating learning for students?
2. How well do you think that you understand the concepts of differentiating learning for students?
3. How skillful do you think you are at differentiating learning for students?
4. How well does the current educational system support your ability to differentiate learning for students?
5. When using apps in the classroom, what did you do differently with your students when teaching mathematics/reading than what you normally do?
6. How did you make assignments for the students on the use of the apps (or did you)?
7. How did students react to the use of the apps?
8. What were some changes in their behavior or attitude towards learning mathematics/reading?
9. Did you group students and if so how?
10. Did the apps the students used allow them to learn in a way that they liked to learn?
11. Did the apps the students used provide them the content they needed to learn right now to support your learning goals for them?
12. What type of support have you received from your division/school during the pilot? Did the support enable you to work with students more one-on-one or in small groups? If not, what would allow you to do that?
13. What type of support would allow you to individualize instruction for your students so that they are focusing on the learning they need in a way that they learn best?
14. What do you expect you will see with student scores on tests after this pilot?

For Treatment teachers only:

1. At which point in the eSpark process did you see this work well? At which point did you see it not work particularly well?
2. How did you adapt to monitoring students who were all working on different goals/apps/paces? How did the students adapt?
3. How well did the eSpark process match students to their ability level?
4. Did you see evidence that students learned too quickly or too slowly based on your expectations? If so, why did that happen, do you think? How did you handle that situation if it happened?
5. Were the demonstrations of learning (the video assignments) appropriate for each student? Would other assessments be useful? Do you have any suggestions?
6. Did the demonstrations of learning provide enough evidence of achievement?
7. How did you use the Teacher Dashboard (or did you)? What did you find most helpful about this tool? What would you like for the tool to be able to do?
8. Did you use the eSpark helpline (Control Center)? How often? Did that solve any issue you had (each time accessed)? What would you like the helpline to be able to do?

Questions for technology support personnel:
In regard to both Treatment and Comparison teachers (probe for specific examples):

1. What changes did you see in the way the teacher taught when using the iPad with the students?
2. Did you observe any changes in the way the students felt about reading/math after they used the iPads?
3. What type of assistance did the teacher need to participate in the pilot?

In regard to Treatment teachers only:
The aim of eSpark is to differentiate instruction so students get instruction and support on the skills and knowledge they most need right now, given input from test data and the teacher.

4. Did you see any evidence that the eSpark process supported differentiated learning?
5. What issues were raised by the use of the eSpark process?
6. What type of support did the teacher have, and did she take advantage of the help, if needed?

Questions for all students (probe for concrete examples):

1. Since January you have been using the iPad to learn some new things. What did you like about that?
2. Was it easy for you to use the iPad?
3. Is there any problem for you in using the iPad for learning?
4. Are you a good learner in general? Did the iPad help you learn better, worse or no change?
5. How did you communicate with your teacher during the times that you used the iPad? Is that different from the rest of the learning time?
6. Do you think that using the iPad helped you to learn what you need to know right now? Do you think you did better on your tests because of it?

Questions for the Treatment students only:

1. Did you like the Challenges you did? (probe for what they liked or didn't)
2. Do you think the Challenges helped you learn better than you would if you didn't have them?
3. Did you end up finishing up too quickly? What did you do to end up so quickly? Did you have to go back and do some of the activities again or did you learn enough the first time?
4. Do you think creating a video at the end to show what you learned was helpful for you? Did it let your teacher know about how much you learned?

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